TO: MS. LAURA RIPLEY
USEPA

FROM: ANITA ALEXANDER
NASA LERC

SUBJECT: COMMUNITY RELATIONS

MATERIAL SUBMITTED (*The enclosed material is submitted herewith*)

---- IN RESPONSE TO YOUR REQUEST
XXXX
---- FOR YOUR INFORMATION

---- FOR DIRECT REPLY

---- FOR INFORMATION UPON WHICH TO BASE A REPLY
XXXX
---- FOR YOUR COMMENTS AND/OR RECOMMENDATIONS

---- ON LOAN: TO BE RETURNED WITHIN ______ DAYS

ACTION (*Check and complete*)

---- FOLLOW-UP FOR REPLY

---- FORWARD ______ COPIES OF ITEM(S) LISTED UNDER REMARKS

REMARKS

ENCLOSURES

1. The introduction chapter of our RI/FS Field Sampling Plan

SIGNATURE OF INDIVIDUAL FORWARDING MATERIAL Anita Alexander
DATE 1/20/94

1.0 INTRODUCTION

1.1 Purpose and Scope of this Document

This Field Sampling Plan provides the detailed information necessary to implement Phase I of the RI/FS field investigation at the Lewis Research Center (LeRC) of the National Aeronautics and Space Administration (NASA). This document presents a summary of the site background and project description, the sampling objectives, the sample locations and frequency, and the specific field procedures and equipment for each of the sampling tasks planned for this investigation. Although this Field Sampling Plan has been developed as a stand-alone document, the procedures presented herein must be implemented in conjunction with the following companion documents:

- Phase I RI/FS Work Plan (WP) currently underway @ LeRC
- Phase I RI/FS Quality Assurance Project Plan (QAPjP)
- Phase I RI/FS Health and Safety Plan (HASP)

1.2 Phase I RI/FS Rationale and Objectives

A number of previous studies have been conducted at the LeRC prior to this effort ranging from site specific to base-wide assessments. The majority of these studies focused on specific events which occurred at the LeRC (eg. UST removals and construction programs) or general environmental/demographic information on the installation. Some of the historical data may not be useable due to the absence of quality control data when attempting to assemble a base-wide conceptual model. Because of the complexity of the LeRC, the historical use of the facility, and the nature of the existing data, a phased approach to the Remedial Investigation/Feasibility Study (RI/FS) will be implemented.

In order to properly design the RI/FS Work Plan at the NASA LeRC, it must be understood that the facility has a large number of areas which require investigation. These areas are typically small, localized in nature, and possess unknown boundaries. Many of the areas of concern were utilized for multiple short term operations during the

50 year history of the facility. These activities were often conducted independently of each other with differing materials and processes being utilized. The historical operations at the facility have increased the likelihood that any one area has the potential for multiple contaminants of concern.

The intent of the phased approach is to provide a thorough investigation of the facility which will characterize and evaluate of the environmental impact posed by the AOCs as well as determine remedial alternatives for the same. The two (2) phased approach to the RI/FS is intended to optimize the available resources and maximize the efficiency of the investigation. The Phase I investigation will attempt to confirm or refute contamination at AOCs and characterize the contaminated sites. Phase II of the RI/FS will focus its scope and resources on the final characterization of the nature and extent of contamination at the facility, the evaluation of the contaminants with respect to the risk to human health and the environment, and the determination of remedial alternatives as well as remedial goals.

The overall objective of Phase I of the RI/FS is to attempt to characterize and evaluate the aggregate environmental impact posed by the Area of Concerns (AOCs), rather than focusing on each AOC individually. This is the premise on which the Project Management Unit (PMU) concept was designed. The Phase I investigation is designed to verify or refute questionable historical data and further develop the conceptual models for the RI/FS process. During Phase I of the RI/FS, an evaluation of all of the PMUs will be conducted on an individual basis. The goal is to delineate those areas which pose a significant threat to human health or the environment and focus NASA's resources on those areas. Phase I of the RI/FS will further serve to determine the most appropriate regulatory approach for each of the 11 PMU's. The CERCLA investigative process may not be suitable for all of the PMUs and therefore, Phase I of the RI/FS will seek to determine the proper regulatory niche that each PMU falls into (e.g. CERCLA, RCRA, BUSTR, etc.).

The Preliminary Assessment[1,2] presents certain complexities when considering the initiation of Phase I of the RI/FS. The following considerations were incorporated into the project rationale:

- LeRC is located in a heavily industrialized and heavily populated area. Potential off-site and on-site contributions to any observed contamination must be differentiated;

- LeRC contains a large number of AOCs over a relatively small area (e.g. 56 of the 63 AOCs are located in an area of less than 200 acres);

- Some of the 63 AOCs were identified based on combinations of anecdotal evidence and soil sampling data of variable quality;

- Specific information (e.g. verified production records, shipping manifests, quality controlled sampling data) regarding the nature or quantity of hazardous substances potentially released from these AOCs was generally unavailable;

- Preliminary HRS scores did not identify any sources, or groups of related sources, that scored near the 28.5 level, the criterion for sites to be placed on the National Priorities List;

- None of the AOCs warranted emergency removal actions;

- The resulting impact of LeRC operations on the environment was not obvious based on the available data;

- The surface water pathway was identified as the most probable route for contaminant migration from LeRC (and upstream contributors) to the surrounding environment; and

- The role of the soil exposure, groundwater, and air release pathways was determined to be less significant from the standpoint of direct contact, but may be contributing factors to the surface water pathway.

The Preliminary Assessment[1,2] evaluated the potential pathways of migration from LeRC to the environment. Surface water, which is fed by groundwater discharge and surface runoff, was determined to be the primary pathway of potential migration of contaminants from LeRC.[1,2] The air pathway does not impact the surface water pathway but must be considered during this investigation due to the working population at LeRC on a daily basis. The four major migration pathways to the environment, all of which were considered during the development of the Phase I RI/FS Field Sampling Plan, include:

Surface Water Pathway. Surface water is hypothesized to be the most significant pathway for contaminants to migrate offsite from LeRC. More than half of LeRCs perimeter is bordered by the flood plain of Rocky River and its tributary, Abram Creek. Nearly all of the 63 AOCs have the potential to affect surface water through direct runoff, discharge through storm sewers, and groundwater discharge. Characterization of the Flood Plain PMU early in Phase I of the RI/FS will provide data that can better quantify the impact on human health and the environment posed by the AOCs at LeRC. Although the potential impact to downstream drinking water supplies is believed to be minimal due to considerable dilution and the downstream distance to the Cleveland water supply intakes, sensitive environmental and human receptors are located within the flood plain system and could be impacted if contaminants are migrating from the site.

Groundwater Pathway. Groundwater is considered to be a less significant migration pathway than surface water, due to documented low yields of area groundwater wells which has resulted in a small target population (i.e. groundwater users). Potential contaminant releases via this pathway must be investigated at LeRC because of the possibility that groundwater eventually discharges to the surface water pathway.

Soil Exposure Pathway. Although the majority of AOCs are associated with potential soil contamination, this pathway is not considered to be a significant exposure route to the general public, because the facility is government-controlled and access is restricted. The exception lies in the West Area PMU (PMU 10), where the proximity of potentially contaminated soil to the LeRC Day Care Center warrants further investigation. The accuracy and validity of the soil data associated with the Day Care Center was evaluated during the PA Supplement, and it was discovered that the soil samples were analyzed under substandard Quality Assurance/Quality Control (QA/QC) conditions. The analytical results for the soil samples reported relatively low concentrations of contaminants which are known to be common laboratory contaminants. Reportedly, laboratory personnel commented that the reported values for the soil samples from the Day Car Center were likely due to laboratory contamination. Due to the suspect nature of these soil results, the Day Care Center was not counted as a resident population in the HRS soil exposure pathway scoring in the PA Supplement.[2] This potential for direct contact with the contaminated soil in the vicinity of the Day Care Center, will be evaluated during Phase I of the RI/FS.

Air Release Pathway. Although little information exists regarding airborne contamination, none of the AOCs is expected to have a significant potential for airborne releases. However, a limited potential exists for airborne transport of contaminants via fugitive dust during construction activities, and for the release of volatile contaminants from wastewater-related sources. Because the USEPA HRS air pathway scoring method considers the total estimated worker population as an on-site secondary air target, the air pathway component scores tend to be elevated relative to the other pathway scores, despite the lack of documented air sources. These potential sources of airborne contaminants will be evaluated during Phase I of the RI/FS.

Based on the conclusions of the Preliminary Assessment[1,2], a detailed investigation plan was developed using the existing data to preliminarily characterize the site and guide the sampling program. The Phase I RI/FS Work Plan and associated sampling activities were developed using Ohio EPA Generic Statement of Work for Remedial Investigations / Feasibility Studies (May 1992) and the USEPA's Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, (October 1988). Phase I of the RI/FS is designed to fulfill the following objectives:

- Provide quantitative verification of previous data used to identify the Areas of Concern (AOC) at the LeRC.

- Evaluate each of the Project Management Units (PMUs) according to the Hazard Ranking System (HRS).

- Initiate the investigation to evaluate immediate and long-term potential threats to human health and the environment for each of the 11 PMU's.

- Establish background levels of contaminants of concern for the major media and migration pathways.

- Investigate the major migration pathways to detect the occurrence of any releases from the LeRC to the external environment.

- Begin the identification of chemical and media specific Applicable or Relevant and Appropriate Requirements (ARAR's).

- Develop preliminary chemical and media specific remedial action alternatives and the data needs to evaluate them.

- Refine the conceptual model for each PMU making recommendations for the Phase II RI/FS Investigation.

1.3 Facility Description

The Lewis Research Center (LeRC) is located in the southwest corner of the City of Cleveland in Cuyahoga County, Ohio (Figure 1-1). The 352-acre site is bordered to the east by Cleveland Hopkins International Airport. It is bordered to the north and west by the Rocky River Reservation which is part of the Cleveland Metropolitan Park District. The southern boundary of the site is adjacent to residential and business districts of the City of Brook Park. The LeRC site is located between Latitudes 41°24'30" and 41°25'N and between Longitudes 81°51'30" and 81°52'15"W. The facility location and site boundaries are shown on the United States Geological Survey (USGS) Lakewood Quadrangle Map as indicated in Figure 1-2.

LeRC is the principal NASA facility for research and development of space power generation and advanced propulsion. Major research activities include aeronautical and space propulsion, nuclear and solar energy conversion systems, space power and space communications technology, space station technology, and terrestrial energy technology.

LeRC began operations in 1941 as the Aircraft Engine Research Laboratory of the National Advisory Committee for Aeronautics (NACA) and became part of NASA when that agency was formed in 1958. Research and support facilities have been expanded continuously over the past 50 years. LeRC presently includes approximately 146 buildings and structures with a diverse array of laboratories, office buildings, research and test facilities, and support facilities. The PA describes the major research facilities at LeRC[1].

The LeRC site is separated into four geographic subareas. The North Area is the portion of LeRC north of Brook Park Road and contains two administrative office buildings. The Central Area is the largest region and is bordered by Brook Park Road to the north, and Cedar Point Road to the south. The West Area is located west of Abram Creek and the South Area is the region south of Cedar Point Road. These natural geographic divisions were considered in the PA Supplement and formed the starting point for defining the boundaries of the PMUs.[2]

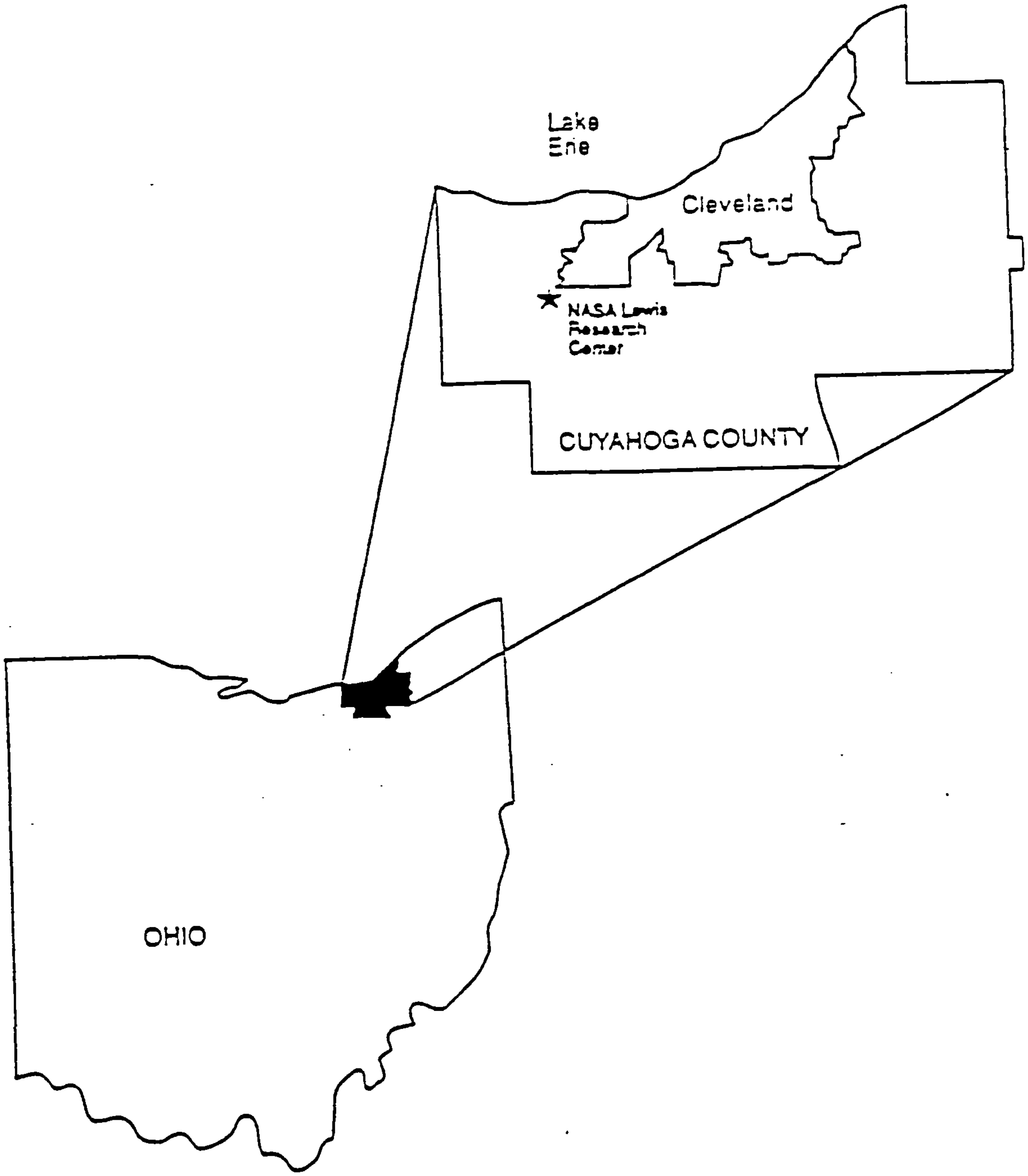

FIGURE 1-1 Facility Location Map

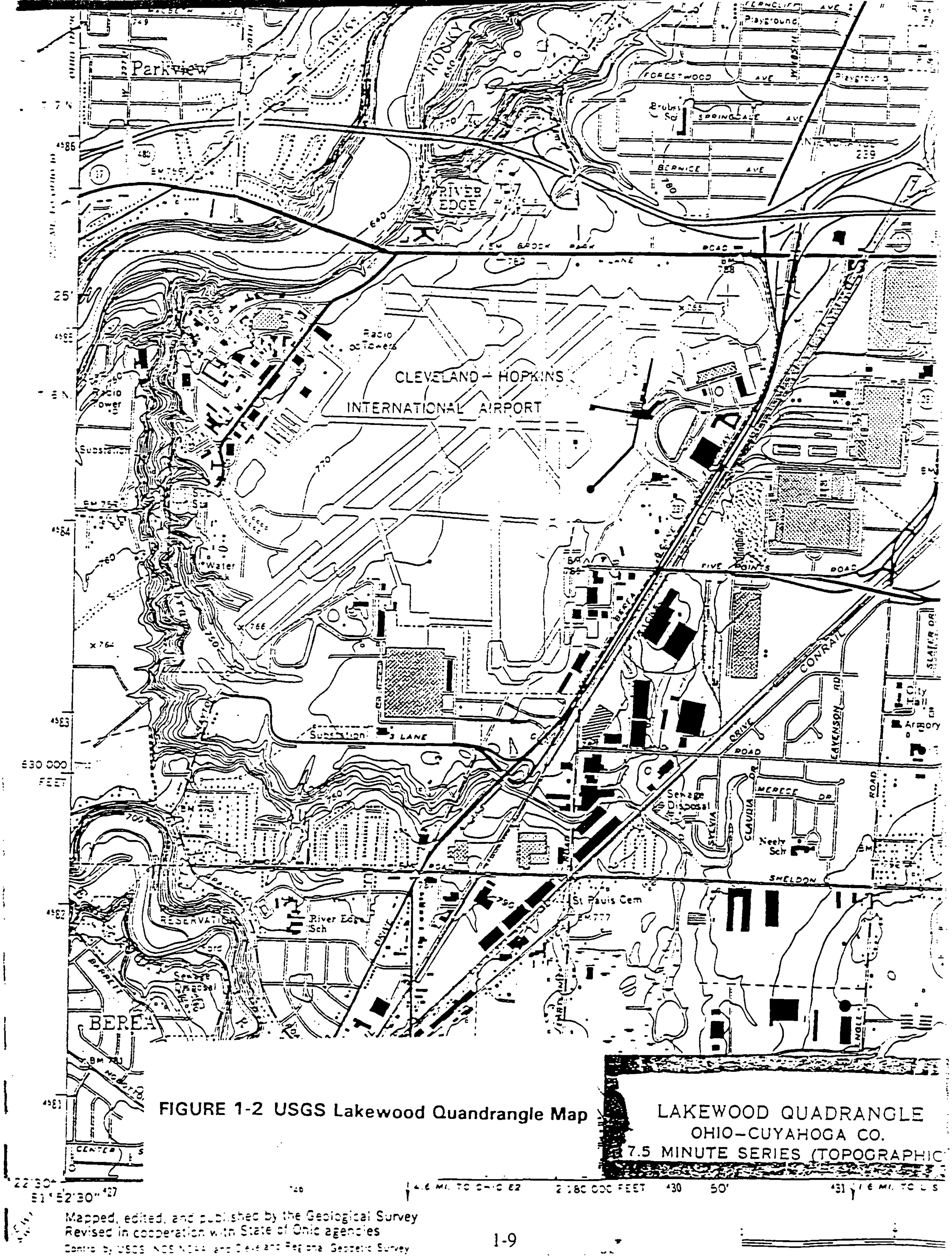

FIGURE 1-2 USGS Lakewood Quandrangle Map

Site utilities (electricity, water, and sewage disposal) are connected to systems that serve the City of Cleveland and Cuyahoga County. Electricity is supplied by the Cleveland Electric Illuminating (CEI) Company, a Division of Centerior Energy Corporation. Potable water is supplied by the City of Cleveland, Division of Water, which uses Lake Erie as its water source. LeRC is served by separate sewer systems for sanitary, storm water, and industrial waste. The sewer lines are constructed of a variety of materials, including vitrified clay, polyvinyl chloride (PVC), galvanized steel, and cement. Sanitary sewage is discharged to the Northeast Ohio Regional Sewer District's Southerly Wastewater Treatment Plant. Storm water run-off from the site is discharged through 42 National Pollutant Discharge Elimination System (NPDES)-permitted outfalls to Rocky River and Abram Creek. Treated wastewater from the Industrial Waste System (IWS) is principally discharged from Outfall 001 (one of the permitted storm outfalls), but may also be discharged to the sanitary sewer system.

1.4 Project Description

The initiation of Phase I of the RI/FS is based on the need to acquire data regarding the AOCs identified during the Preliminary Assessment[1] and Preliminary Assessment Supplement Report[2] as well as begin focusing on the Remedial Investigation. During Phase I of the RI/FS, an evaluation of the entire facility will be conducted to identify those areas which pose a potential threat to human health or the environment and to focus the available resources on those areas which need attention.

The Preliminary Assessment (PA) conducted at LeRC identified 63 areas of concern (AOCs) across the facility.[1] All 63 AOCs were recommended for further study. The specific AOCs and the contiguous 352-acre LeRC facility have been divided into 11 Project Management Units (PMUs) to facilitate the characterization of each AOC in a well organized and cost-efficient manner. The PMU approach will allow the Phase I RI/FS to incorporate an economy of scale by coordinating similar investigative activities conducted on multiple AOCs. The development of the PMUs and assignment of AOCs were based on four principal criteria:

- Geographic layout of the LeRC site and the proximity of the AOCs;
- Similarities in suspected types of contamination and affected environmental media;

- Existing level of knowledge regarding the nature of the AOCs and potential for remedial response actions; and

- Similar age, facility type and building usage.

On the basis of this criteria, the 11 PMUs were created encompassing the entire facility and all 63 AOCs. The 11 PMUs are identified as follows:

PMU Number	PMU Designation
PMU 1	Flood Plain
PMU 2	Industrial Waste System (IWS)
PMU 3	Storm Sewer System (SSS)
PMU 4	Rocket Laboratories Area
PMU 5	South Area
PMU 6	Building 50 Area
PMU 7	North Perimeter
PMU 8	North Central
PMU 9	South Central
PMU 10	West Area
PMU 11	North Area

PMUs 1, 2 and 3 were established as facility-wide or system PMUs due to their susceptibility to the introduction of contaminants from all base operations. The remaining PMUs were delineated primarily based upon area use or accepted geographic descriptions. The Flood Plain PMU (PMU 1) was created because surface water was established in the PA as the principal pathway for contaminant migration from the identified AOCs off-site to the external environment. A comprehensive characterization of this PMU during the Phase I RI/FS will provide the data to better quantify the threat posed by the LeRC AOCs to human health and the environment and provide a firm basis on which to prioritize activities at the other PMUs. In addition, information collected from the Flood Plain PMU will help identify AOCs which were not categorized during previous investigations, including potential sources which lie upstream from LeRC.

The Industrial Waste System PMU (PMU 2) was delineated because it discharges to the Flood Plain (PMU 1) and the sanitary sewer system and its impact can be controlled at the retention basin discharge points. The Storm Sewer System (PMU 3) was established because of the need to assess the impact of upstream, off-site contaminant sources and because it also discharges to the Flood Plain PMU. Investigations of the Industrial Waste and Storm Sewer System PMUs will help differentiate NPDES issues from RCRA, CERCLA and Bureau of Underground Storage Tank Regulation (BUSTR) issues.

The Central Area, being the largest single region on LeRC, was divided into five separate PMUs to permit a more effective characterization of the impact to this area. The Rocket Laboratories Area (PMU 4) was delineated based on the nature of the contaminants anticipated to be found and an expected high priority for future work due to previously documented contamination at Building 109. The Building 50 Area (PMU 6) was established because AOCs in this area have been extensively characterized with geophysical, soil gas, and hydrogeological investigations. Several underground storage tanks and associated contaminated soil have been removed from this PMU and it is expected to receive a high priority for future work. The North Perimeter (PMU 7), the North Central (PMU 8) and the South Central (PMU 9) PMUs were delineated based upon the nature of contaminants in the areas, the proximity of AOCs to one another and building age and use.

The South Area (PMU 5), the West Area (PMU 10), and North Area (PMU 11) PMUs were delineated based on long standing geographic breakdowns at LeRC. Over the years of operation, the South Area has been the location at LeRC where landfills, salvage areas, fire training areas and chemical storage areas were established. This PMU has the potential for direct impact of surface water receptors and retains a high priority for future work.

The PMUs discussed above are indicated in Figure 1-3. The boundaries outlined in this figure may be subject to change as new information is acquired during the Phase I RI/FS. Contaminant plumes which extend across one or more PMU boundaries may require an adjustment to the original boundary lines. Table 1-1 summarizes each PMU, including its geographic extent, the AOCs it contains, the principal contaminants of concern and the rationale for its development.

Figure 1-3 Delineation of PMUs at NASA LeRC (Showing all 11 PMUs)

Table 1-1 Project Management Units for Phase I RI/FS Activities

Name	Geographic Area	AOCs Included	Principal Contaminants of Concern	Rationale
Flood Plain (PMU 1)	Rocky River, Abram Creek and its tributaries, including all flood plain areas	Bldg. 415 (UPR-C-12) Pistol and Rifle Range	Mercury and other metals, organic compounds, including petroleum hydrocarbons	Principal pathway to external environment. Study will help quantify any LeRC impacts on the surface water targets. Study will allow LeRC to differentiate its impacts from those of upstream sources. Data from PMU 1 will assist the investigations of other PMUs.
Industrial Waste System (IWS) (PMU 2)	IWS sewers, separator pits, and outfalls	IWS Retention Basins (SFI-C-1), IWS Outfalls (OFL-C-1), Oil/Water Separator Pits (UST-C-7), Iws Catch Basins and Manholes (UPR-C-10)	Mercury and other metals, organic compounds, including petroleum hydrocarbons	Suspected significant source of contaminant releases to surface water targets. Data from this investigation will help isolate NPDES problems from environmental remediation program concerns and may help locate AOCs within other PMUs.
Storm Sewer System (PMU 3)	Storm sewer and outfalls throughout LeRC	Storm Sewer Outfalls (OFL-C-2)	Mercury and other metals, organic compounds, including petroleum hydrocarbons	Suspected significant source of contaminant releases to surface water targets. Data from this investigation will help isolate contributors upstream of LeRC, and NPDES problems from environmental remediation program concerns.

Table 1-1 Project Management Units for Phase I RI/FS Activities (Continued)				
Name	Geographic Area	AOCs Included	Principal Contaminants of Concern	Rationale
Rocket Laboratories (PMU 4)	Area surrounding Bldg. 109 and Bldg. 35 Complex and west to Abram Creek	Bldgs. 109 (UPR-C-14), 136 (UPR-C-13), and 35 Complex (UPR-C-15)	Organic compounds, mercury and other metals, radionuclides	High priority for further work based on anticipated regulatory concerns.
South Area (PMU 5)	Entire South Area	South 40 Landfill (LNF-S-1), Salvage Areas I and II (UPR-S-6 and UPR-S-1), Bldgs 203/204 (UPR-S-2), Fire Training Pit (SFI-S-1), Pesticide Storage Location (UPR-S-3), Substation A (UPR-S-5), Old Landfill and 1957 Landfill (LNF-S-2 and LNF-S-3), Old Salvage Area (UPR-S-7), Bldg. 209 and Retention Basin (UPR-S-8 and SFI-S-2), Bldg. 208 and Coal Storage (UPR-S-10 and UPR-S-9), Buried Disposal Pond (SFI-S-3), Salt Storage Area (UPR-S-4)	Mercury and other metals, radionuclides, PCBs, organic compounds, including petroleum hydrocarbons	Existing geographic area, high priority for further work. Potential for direct impact on surface water targets.
Building 50 Area (PMU 6)	Area in east portion of Central Area including Bldgs. 24, 28, 34, 50, 104, 105, and 107	Bldgs. 104 (UST-C-2), 24 (UST-C-1), 28 (UPR-C-3), and 34 (UPR-C-26)	Organic compounds, including petroleum hydrocarbons	Similar types of contaminants and sources (USTs). Partial characterization of area around Buildings 104, 34, and 24 has been performed.
North Perimeter (PMU 7)	Northern portion of LeRC, south of Brook Park Road, including Bldgs. 60, 77, 45, 143, 4, 14, 137, 21, and 15.	Bldgs. 4 (UST-C-4), 21 (UPR-C-2), 14 (UPR-C-3), 77 (UPR-C-27), and 15 (UPR-C-29)	PCBs, organic compounds, including petroleum hydrocarbons	Collection of buildings with similar functions and little existing information regarding contamination sources. Anticipated moderate priority for further investigations.

Table 1-1 Project Management Units for Phase I RI/FS Activities (Continued)				
Name	**Geographic Area**	**AOCs Included**	**Principal Contaminants of Concern**	**Rationale**
North Central (PMU 8)	Northern portions of the Central Area	Bldgs. 5 (UPR-C-5), 23 (UPR-C-7), 7 UPR-C-6), 64 (UPR-C-9), 12 (UST-C-5), 16 (UPR-C-16), 81 (UPR-C-18), 66 (UPR-C-19), 9 (UPR-C-20), 99 (UPR-C-23), 63 (UPR-C-21), 6 (UPR-C-25), 125 (UPR-C-28), Substation B (UPR-C-17), Substation E (UPR-C-1), Site 17 (UST-C-3)	Organic compounds, including petroleum hydrocarbons, mercury, PCBs, radionuclides	Geographic area incorporating buildings with similar operations. Contains some of the oldest facilities at LeRC. Anticipated high priority for further investigations.
South Central (PMU 9)	Southern portions of the Central Area	Bldgs. 49 (UPR-C-24), 54 (UPR-C-8), 110 (UPR-C-4), and Wiggins Farm (UST-C-6)	Organic compounds, including petroleum hydrocarbons, mercury, radionuclides	Geographic area includes most of the wind tunnel operations. Similar types and sources of contaminants. Anticipated low priority for further investigations.
West Area (PMU 10)	All of the West Area	Bldgs. 300 (UPR-W-1), 308 (UPR-W-2), 398 (UPR-W-3), 301 (UPR-W-4), 333 (UPR-W-5), and 322 (UPR-W-6)	Mercury, organics	Existing geographic area, isolated from the rest of the facility. Anticipated low priority for further investigations.
North Area	Northern leg of LeRC including Bldgs. 3, 500 and 501	Bldg. 500 (UPR-N-1)	Petroleum hydrocarbons	Existing geographic area which includes buildings having similar operations (mainly offices). No suspected contamination. Low probability for further studies beyond this effort.

NOTES:

LNF	Landfill	SFI	Surface Impoundment
NPDES	National Pollutant Discharge Elimination Permit	UPR	Unplanned Release
OFL	Outfall	UST	Underground Storage Tank
PCBs	Polychlorinated Biphenyls		

1.5 Environmental Setting

The NASA LeRC is located primarily in a heavily developed, urban/industrial area. Yet it lies adjacent to the Rocky River Reservation, a major park and recreational complex. This contrast provides the potential for both human and ecological receptors to be impacted by the present and past operations at LeRC. The following sections summarize the environmental setting at LeRC.

1.5.1 Site Topography

The generally level topography of the LeRC facility is due to extensive cut-and-fill operations that reclaimed much of the area from steep drainage swales that crossed the site and flowed to Abram Creek and Rocky River. These drainage features are believed to have been filled with a variety of undifferentiated soils and gravels, construction debris, and industrial and domestic waste. The level topography contrasts sharply with the steep valley walls of Abram Creek and Rocky River. The ravines are generally 50 to 100 feet deep, with an estimated maximum sidewall slope of 75 degrees.

1.5.2 Geologic Setting

Information concerning the geologic setting in the vicinity of LeRC is limited. Most of the LeRC facility was developed in the 1940s and 1950s in an era when comprehensive geologic studies were not a prerequisite to major construction. The surface topography and native soils of essentially all of the Central, North, and South areas have been disturbed by construction and cut-and-fill operations. However, significant information is available from visual observation of the river valleys that dissect and border the site.

1.5.2.1 Soil Formations Underlying the Site

During the Pleistocene Epoch, northern Ohio was modified by the Nebraskan, Kansan, Illinoian, and Wisconsian continental glaciation events. Advancing and retreating ice fronts during these glaciation events deposited till and glacial outwash over much of northern Ohio. As the Wisconsian ice front advanced and retreated across northern Ohio, it occupied several positions within the Lake Erie basin and acted as a temporary dam. These ice dams formed several different ancestral lakes. The highest shoreline stood about 800 feet above mean sea level, which is 227 feet above the present day Lake Erie shoreline.[1] Surficial geologic mapping has shown several successive beach ridges consisting of sand and gravel between NASA LeRC and Lake Erie.[1] In northwestern Cuyahoga County the surface is primarily covered by a thin layer (several inches to a few feet) of lacustrine clay and silt deposits that are underlain by Wisconsian aged glacial till.[1]

The naturally occurring soils at LeRC include the Mahoning Association, the Brecksville silt loam, the Chagrin silt loam, and the Jimtown loam. The parent materials of these soils consisted mainly of glacial till and alluvium deposits.[1] Thus, the soils are composed chiefly of clay, silt, sand, and gravel in varying proportions. A large portion of the naturally occurring soils at LeRC have been removed or covered over with miscellaneous fill material over the years as the development of LeRC continued.

Soils of the Mahoning Association cover most of the LeRC Central Area. These soils are classified as a silty clay loam, although they often grade to a clay loam glacial till. The soils generally have low to very low permeability. Thickness of the soil unit is highly variable and difficult to quantify because of the extensive cut-and-fill operations. Over the Central Area, the thickness is estimated to be about 10 to 20 feet, although it may increase up to 65 feet in fill areas.

The Brecksville silt loam is found on the steep stream valley of Abram Creek. Silt and sand dominate its composition, resulting in a soil with very low permeability and relatively low cohesion. Thickness is generally less than five feet.

The Chagrin silt loam is a well-drained soil formed from relatively recent alluvium deposits on the flood plains along Abram Creek. The thickness of the Chagrin loam is generally three to five feet but may be as great as ten feet. The soil has low to moderate permeability.

The Jimtown soils cover most of the West Area of LeRC. These soils have a significant sand and gravel component and are generally poorly graded with moderate to high permeability. The thickness of this unit is generally six to ten feet.

1.5.2.2 Rock Formations Underlying Area

The Cleveland area is located on the western flank of the underformed portion of the Appalachian Basin which extends northeastward from Alabama across portions of Tennessee, Kentucky, Virginia, West Virginia, Ohio, Pennsylvania, and New York. The basin contains a southeastward-thickening prism of sandstones, carbonates, shales, and salts with an aggregate thickness of 6500 to 23,000 feet. Sedimentation in the basin occurred throughout the Paleozoic Era (600 to 246 million years before present) and culminated at the end of the last Appalachian Orogeny.[1]

Bedrock in western Cuyahoga County crops out along stream valleys and escarpments. The total thickness of the bedrock represented by the outcrops in the area is about 750 feet thick and consists of Devonian through Pennsylvanian aged rocks. The stratigraphic sequence of exposed bedrock in the area is shown in Figure 1-4.[1] Pre-glaciation erosion of the land surface created several large, narrow stream valleys in the Cleveland area. These pre-glacial stream valleys are from one to two miles wide. These features have since filled with glacial sediments and no longer have any recognizable topographic expression. The Cleveland Hopkins International Airport is underlain by one of these buried pre-glacial stream valleys. This valley is known to extend at least 350 feet below the land surface.[1] The exact location of the western boundary of this feature is not known. If this buried stream valley underlies a portion of the LeRC site, it would most likely have a significant impact on groundwater flow at the site.

1.5.3 Hydrogeology

Little is known about groundwater flow at the LeRC site because groundwater is not used as a source of water at LeRC and minimal groundwater use occurs within a four-mile radius from the site.[3] Groundwater is expected to

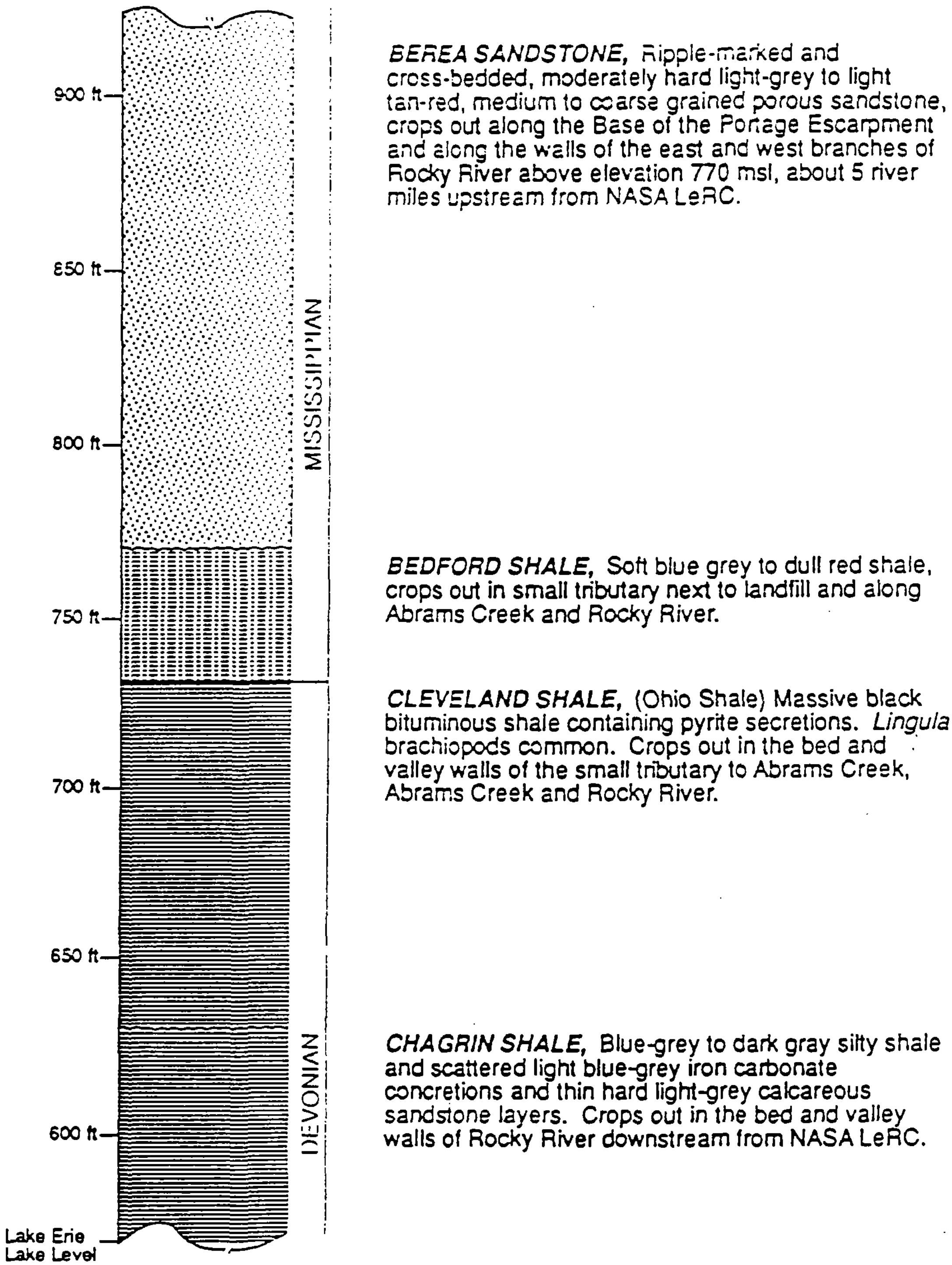

FIGURE 1-4 Generalized Stratigraphic Column for Rocks Exposed at the Surface in the Vicinity of NASA LeRC

occur in two distinct zones: one in the shale bedrock and the other in the overlying unconsolidated fill and glacial till. Groundwater also may occur as perched lenses within the localized permeable, unconsolidated fill material. Groundwater flow beneath the site is expected to mimic the general surface topography, and flow toward Abram Creek and Rocky River.[4] Groundwater flow may be locally influenced by the type of fill material and the distribution of different kinds of fill over the area.

Groundwater flow in the shale bedrock has not been defined. Winslow[1] reported that the shale bedrock beneath NASA LeRC is a poor source of groundwater, and low yields of three to four gallons per minute are typical of most wells in the area. A survey conducted in 1969 by the Ohio Department of Natural Resources (ODNR)[5] found that only 220 individuals in the entire Rocky River basin (an area almost 300 miles square) obtained their drinking water from groundwater sources.

The closest water well on record with the Ohio Division of Water is located about 1/4 mile west of the LeRC site boundary on Cleveland Hopkins International Airport property. The well log and drilling report (Report No. 198445) filed with the Ohio Division of Water indicates the well was drilled to a total depth of 80 feet below the surface, encountering shale bedrock at 41 feet below the surface and groundwater at 43 feet below the surface. The drilling report also stated that the well had been developed to a yield of one gallon per minute. This well was installed in 1957, but it is not believed to be still in use. File searches of city, county, and state regulatory agencies revealed records for a total of 31 wells drilled within the four-mile radius of LeRC and east of the presumed Rocky River groundwater divide. Only seven of the wells are currently permitted by the city and county health departments as sources of domestic or commercial drinking water. Inquiries into the status of the unpermitted wells indicated that they had generally been abandoned due to the significant commercialization of the southwest Cleveland suburbs and the expansion of the Cleveland municipal water supply system in the last five to ten years. The location and usage of groundwater wells are further discussed in Section 1.4.5.2.

1.5.4 Surface Water Hydrology

Surface water hydrology in the vicinity of LeRC is dominated by Rocky

River and its tributary, Abram Creek. Detailed hydrologic data are not available for Abram Creek, but visual estimates indicate that the flow is approximately five to ten percent of the flow observed in Rocky River. The stream begins in a low-lying area south of Cleveland Hopkins International Airport and flows onto LeRC at its southern boundary. Abram Creek flows approximately 6500 feet through LeRC separating the West Area from the rest of the facility, prior to its confluence with Rocky River approximately four miles from its headwaters. The stream flows through a heavily industrialized portion of Cuyahoga County which provides the potential for several upstream sources of contamination. These potential sources include Cleveland Hopkins International Airport, a major automotive foundry, and a former U.S. Army ordinance plant. A wastewater treatment facility in Brook Park, Ohio discharges into Abram Creek approximately two miles upstream of the LeRC southern boundary.[1,6]

Rocky River is a third-order stream with an average daily discharge rate of 276 cubic feet per second as measured by the U.S. Geological Survey (USGS) gaging station (No. 04201500) located approximately 1.6 miles upstream at the Cedar Point Road Bridge. The USGS estimates the total drainage area for the Rocky River watershed to be 267 square miles.[10] Rocky River flows north to Lake Erie, approximately 9.2 miles downstream the North Area at LeRC.[1] Two wastewater treatment facilities discharge into Rocky River upstream of the LeRC. The first is located in Berea, Ohio and discharges into the East Branch of Rocky River approximately three miles upstream from its confluence with the West Branch of Rocky River. The second is located in North Olmsted, Ohio and discharges into Rocky River approximately 0.8 mile upstream from its confluence with Abram Creek.[6,7,8,9]

Potential points for contaminants from LeRC to enter Abram Creek and Rocky River are the numerous storm sewer outfalls from the facility. Most of the surface water run-off from the South Central, West, and South areas of LeRC is collected by natural swales and the storm sewer system and is diverted to outfalls along Abram Creek. The majority of the storm water run-off from the North Central and north Areas is collected in a similar manner and is diverted to outfalls along Rocky River. Although most of the precipitation is believed to flow overland, several low volume seeps have been observed along the Abram Creek valley walls following periods of heavy rainfall.[11] This indicates that a portion of the precipitation does penetrate the surface, percolating through the soil and fill material.

The portions of Abram Creek and Rocky River which border the LeRC site are located in relatively narrow, steep-sloped valleys which have cut through the surficial soils and into the bedrock. The typical water level in these drainage patterns is generally 50 to over 100 feet below the LeRC site surface. The 100-year flood plain lies within these steep valley walls as they cut through the LeRC facility. Due to the depth of the stream valleys and the differences in elevation between the stream beds and the facility, significant flooding of any portion of the facility outside of the 100 year flood plain is considered unlikely.

1.5.5 Drinking Water Supplies

The surface water resources in the vicinity of LeRC are much more prevalent than groundwater as a source of drinking water. As described in Section 2.2.3, groundwater sources serve in an extremely limited capacity due to low well yields. The following subsections describe both the surface water and groundwater supplies which serve LeRC and the surrounding area.

1.5.5.1 Surface Water Supplies

There are two municipal water systems that extract their water supplies from sources within 15 miles of the LeRC site boundary. The City of Berea and the City of Cleveland. The City of Berea extracts its water supplies from the Rocky River at a facility located approximately five river miles upstream from the LeRC facility boundary.

The City of Cleveland, Division of Water is the major water supply system in the region. This system provides water to the City of Cleveland and 67 surrounding communities including LeRC. The system supplied a total of 110 billion gallons of water in 1989 to a total user population of over 1.5 million people.[13]

The Cleveland System draws its water from Lake Erie through four intakes. The intakes are located from 2.5 to 5 miles off-shore. Three of the four intakes are within a 15-mile radius of LeRC. The closest intake to LeRC is situated approximately 12.6 miles from LeRC, (based on a distance of 9.2 river miles from the LeRC site boundary to the mouth of the Rocky River).

1.5.5.2 Groundwater Supplies

Groundwater is a very minor source of drinking or industrial use water in the vicinity of LeRC. Only seven permitted drinking water wells were identified from the Cuyahoga County and City of Cleveland Health Department records within four miles of LeRC.[1] These wells are located between 1.5 and 3 miles south and southeast of LeRC and serve an estimated 50 individuals. In 1969, the ODNR identified only 220 individuals in the 300 square-mile drainage basin of the Rocky River that relied on groundwater for their drinking water source.[5]

1.5.6 Air Quality

The ambient air quality at the LeRC facility is influenced by NASA operations, land management practices, vehicle traffic, and emission sources outside of the site. Daily air quality is most influenced by vehicle traffic. Major transportation arteries surround the site providing access to Cleveland Hopkins International Airport, a major shopping center and industrial, commercial, and civic facilities in the downtown area of the City of Cleveland. These facilities can also be significant sources of air pollutants.

The City of Cleveland Division of Air Pollution Control currently operates 23 sampling stations in Cuyahoga County. A review of the 1988 data (the latest year for which data were available) shows compliance with primary and secondary National Ambient Air Quality Standards (NAAQS) for total suspended particulates (TSP), sulfur dioxide, nitrogen dioxide, carbon monoxide (CO), and lead during 1988. This represents progressive improvements over the last ten years, as ambient concentrations generally decreased and are generally well below NAAQS standards. The Cuyahoga County area did exceed the standards several times for TSP and once for CO in 1987.[12]

The ozone levels have occasionally exceeded the standards during times of calm winds and hot weather. For this reason, Cuyahoga County and the surrounding area are considered a non-attainment area for ozone. Although these exceedances have occurred only occasionally during any one year, they have occurred rather consistently on a year-to-year basis. Because of this, Lorain County (to the west of LeRC), Cuyahoga County, and Lake County (to the east and downwind of LeRC) have imposed an Inspection/Maintenance Program for automobile emissions in an effort to reduce volatile organic compound (VOC) and nitrogen oxide emissions, which are precursors to ozone formation.[12]